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ABSTRACT

Problems and issues related to the financing and use of educational technologies in Arizona schools are addressed from both short- and long-term considerations. A brief review of the spread of computers in schools includes projections for future use of computers in education and a discussion of factors affecting the market, the convergence of technologies, and emerging trends. Pro and con viewpoints on critical issues related to school use of technology are outlined, and three possible scenarios for computer implementation are described. Additional topics include problems in accounting, market variables such as price attrition, and teacher training. Recommendations are made for implementing computers and for financing their acquisition through donations by educational technology producers and citizens (e.g., through tax credit plans), federal surplus, and public resources. Financing protocols are suggested, as well as measures for capital accumulation and equalization and data entry standardization. Twenty readings are listed. Appendices include results of a survey of computer distribution in Arizona schools and charts showing the computer purchasing cycle in schools and colleges, key buyers in public school districts, and microcomputers by brand in public schools. (LMM)

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INTRODUCTION

Quality research, research designs and methodology evolve from a variety of conditions -- not all academically related. The objective of the NACCIS Working Papers is to provide the public with an intimate glimpse of an independent non-profit grass roots research group. We're teachers, academics, computer buffs, senior citizens, students, engineers, psychologists and artists. We share with you here, our developmental processes which, in some cases, have lead to the production of what we consider interesting research hypotheses.

We are aware that the current educational technologies research environment is faced with two seemingly paradoxical situations: there is both too much and too little information. In an age where information doubling is occurring every 20 months, the frequent dilemma of research oriented facilities is that of compounder of confusion by virtue of investigation. That is, the products of our research may contribute to a body of knowledge that is useful academically, but also often serves to

confuse and misdirect the public. Do we add to the research base responsibly? Indeed, do we make adequate use of the already existing body of research? Do we make use of the existing research to correlate productive problem-solving approaches?

On the other hand, there is also the possibility that the newness of the technology may temporarily intimidate many "mainline" educational researchers. Additionally, many researchers may feel that their work is more fundamentally oriented and that new technologies are not going to have significant influence in their specific area of application. For the practicing teacher who is attempting to synthesize theoretical information and incorporate new educational technologies into the classroom, the area must seem at times both overwhelming and underwhelmed with practical ways in which to test out the "revolutionary" new ideas of technology.

In looking back at our ideas we have, at times, found some of them insightful, some powerful, and some--due to hindsight and experience--quite ludicrous. But, we make no apologies. We've provided these partially digested working papers as a means of stimulating your own creativity, curiosity and wonder.

The NACCIS Research Staff hopes you will find these papers useful and would appreciate your feedback. In the world of research, the greatest breath of fresh air comes simply from an open mind.

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INTRODUCTION

In February of 1984 according to one survey, 80% of the America's 2000 largest schools had at least one microcomputer, whereas 60% of the poorest 2000 had none (TLC, 1984). The existing base of 1.6 million computers in classrooms have been financed through a variety of means. According to the 1983 Arizona School Survey of Computers in Instructional Use, out of a potential of 904 public schools sampled in the state, 476 reported using computers for instruction (53%). Since Arizona is among the top thirty states, it would not be reasonable to expect parity with more populous states such as California; but, it is also interesting to note that the bellwether state of California has already reached 100% saturation (at least 1 computer for every school) (NCII Annual Report, 1983).

An account from some California PTA board members purports the 45,000 member-schools organization has had a part in financing up to 20% of the computers currently in America's classrooms (Needham, 1984). In addition to outright purchasing of needed technology, there are estimates that some 25 states have school districts banding together in various forms of

coalitia. As the distribution of this technology in the first paragraph indicates, issues surrounding equity of access to technology need to be addressed in any discussion of financing.

Arizona is not alone in attempting to grapple with issues surrounding educational technology. The proliferation of computers between 1982 and 1983 (37% growth) has resulted in a distribution pattern seen in Appendix A. Of the two surveys examined for this working paper, data collection methodology was so varied as to make the instruments relatively noncomparable. There is an obvious need to standardize around the type of data we wish to collect in Arizona on which to base policy decisions.

Following a review of the literature, it may be more useful to look at the problem from the framework of "learning environments," of which educational technologies are a component, rather than being the primary area of focus. We will address issues from both short-term and long-term considerations.

Educational technologies in schools have been a force propelled more from externally perceived pressures than educational theory. And it has been more of a response to proliferation of technologies in business that has resulted in an extension of demands for more sophisticated graduates from our schools. According to Arizona in the Information Age, a publication generated in 1982, Arizona at that time was already home to 150 high technology manufacturers. From 1974 to 1981,

systems analysts grew from 1,010 to 2,642 (161% growth).

Home productivity software and educational software now comprise as much as half of the software for home computers sold today. Input, a California-based market research firm estimates that some 3000 software companies operate a $1 billion a year industry.

Computer + Software News, a newsweekly on retail computer marketing reported in a recent issue that 2.2 million microcomputers will be installed in the nation's classrooms by year end. Computer Strategies International, a market research firm predicts that there will be nearly 5.9 million units in classrooms by 1988. One third of the estimated $300 million that will be spent on acquiring computers between March and October of this year will be accounted for by seven states: Florida, Rhode Island, Indiana, Pennsylvania, Minnesota, New York and California.

In the legislative arena, there are bills before Congress such as the Computer Literacy Act and the National Education Corporation in House Subcommittees. According to testimony given before these subcommittees, a ratio of one computer for every 30 students is projected. According to Arizona Department of Economic Security Population Statistics, in 1983 there were approximately 437,000 K-8 students in Arizona (between the ages of 5-14). The 1983 Arizona Computer Survey of Microcomputers

Being Used for Instruction, captured only a 69% response rate of the possible 900+ schools in Arizona, and reported that among these respondents there were approximately 4054 microcomputers. While it is a gross approximation, it is interesting to note that this represents a 1:107.80 ratio in Arizona, whereas Talmis, the Chicago-based research firm reports a 1 to 68 ratio among Universities. There are those who would dispute any attempt to quote "ideal computer ratios" as being a necessary decision-making yardstick, but the race for federal monies may make this issue more interesting.

The Computer Literacy Act will offer $300 million annually over the next 10 years. The National Education Corporation is meant to act as a funding agency to developers of educational software and would deliver approximately $45 million in Federal funding. At this point, both the Reagan Administration and software houses have both attacked both bills. A third bill, heavily promoted by Apple, would liberalize tax incentives for corporations that donate computers is pending before both houses: the Computer Contribution Act.

Positioning by major foreign technology competitors to control what they perceive is the next economic wave is significant. Toshiba has recently opened a 3,000 employee software factory, and plans to build a second facility which will employ another 2,000 software engineers in the near future. To

finance such aggressive expansion, the Japanese Ministry of International Trade and Industry (MITI) has assisted the government of Japan in establishing extensive incentives for their private sector to engage in research, and MITI provides low-interest rate loans and other tax breaks to software developers. Even with massive labor resources, it is interesting to note that the Japanese have dedicated themselves to not just the development of software with specific applications per se, but to the design of what they term "productivity enhancement tools" that are intended to make the job of programmers easier.

With rare exception, it seems that schools have acquired technology without an understanding of the convergent factors at work in the market. That is, both hardware and software manufacturers are feeling reciprocal pressures from users to redesign systems so as to provide maximal integration of function and utility. The recent phenomena of software packages that permit users to have multiple "windows" is an example of the former assertion. We live in a multivariable world and the display of multiple files concurrently on the same screen is an indication of the growing sophistication in software development. Even so, software has tended to lag behind hardware development, so that issues involving copyright protection of programs originally written for single machines are often violated when schools have networked computers. The single copy of software

that is often transferred to a hard-disk and then "downloaded" into student stations may represent an act of copyright infringement.

As technology progresses it is bound to converge to a certain extent--technologies from one isolated area becoming functionally integrated into other areas. In doing so, issues surrounding licensure may become more intense over the next few years. Imagine the compounding of the above-mentioned problems of licensure when both voice, visual, and other digital/analog programs are developed for integrated VCR-computer-telecommunications-data base management systems of the not too distant future.

"Convergence" is likely to mean many things as technology develops. Many bold experiments are now underway that could offer alternatives to traditional forms of classroom instruction for many people. For example, in September of 1983, Ron Gordon, former chief executive of Atari, created Electronic University. A San Francisco-based business, TeleLearning Systems, Inc. offers a catalog of 170 courses through Electronic University (not all of which are college level classes). Their plans are for approximately 500 courses by year end.

In addition to the convergence factor, developers of educational and other forms of high technology continue to competitively develop their products. One of the key issues in educational computing revolves around storage devices. That is,

in order for the computer to be truly useful in the classroom, more storage capacity is typically required than is available on a 5.25-inch floppy disk. At present, there are any number of alternatives that are beginning to appear that promise to provide educational computing users with 100 to 200 times current storage capacities in the short-term.

Stretched Surface Recording (SSR) technologies being developed by 3M have been demonstrated at computer showcases such as Comdex (last November). 3M hopes to have SSR disks that also have the added feature of being more resistant to damage by shock, vibration and less vulnerability to dust and smoke particles on the market by 1985.

Perpendicular magnetic recording (PMR) techniques can increase the recording capacity of floppy disks such that disks would be able to store 40 times as much data as they do today.

From the standpoint of emergent trends however, the biggest factor in educational technologies that is changing involves software. Prior to this point, educational computing has been relatively dominated by the hardware side of the industry. Schools have typically bought "machines first." But, this is likely to change as software suppliers progress from being garage-based producers to simple divisions of larger corporate empires. In 1980, only $260 million of personal computing software was sold. By 1989, we could be looking at software revenues of around $6 billion. The 28 year-old chairman of Microsoft, the largest software producer in the country, is estimated to be personally worth $100 million.

When we speak of financing technology, if we say "computers," the stand-alone machines as we know them today must be considered short-term acquitions (2-3 year life cycle). In his fine work, Stanley Pogrow at the University of Arizona has detailed a number of other reasons that we should be cautious at this point in direct public-school investment in technology (Implications of Effective Educational Use of Technology for State Policy: Emerging Issues).

From the manufacturer's point of view, the reality is that in order for educational technology to fully develop and emerge as the power that many anticipate it to be within our society, the consumer must drive the process. This consumer driven process will create the jobs that lead to the increased demand for technology sophisticated graduates from our schools that further drives the process. At present however, the five largest categories of work associated with computers represent a little more than 0.5% of the total work force.

CRITICAL ISSUES

WHY TECHNOLOGY IN SCHOOLS?

Con View Point:

From the standpoint of return on investment, there is not currently sufficient agreement among researchers as to the role, utilization and benefits of educational technology to justify full-scale implementation.

Pro View Point:

Six hundred million non-Americans will enter the international work force before the end of this century and they will work for a fraction of the wages we consider essential to a decent standard of living. To prosper in such an environment, we must think better, work harder and design new forms of cooperative effort. The post-industrial revolution, which America created, has made knowledge and cooperation more important than raw materials. Victory will go to those who can rapidly mobilize the resources of the human mind. -- Nat'l Comm for Ind. Innov.

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TECHNOLOGY SCENARIOS

Technology can assist children in learning, especially in the development of problem-solving skills, in ways that no other form of instructional methodology can claim: current educational computing and future converging technologies will come to resemble human thought processes (dialectic and algorithmic, analog and digital, sequential and simultaneous, gestalt and detail oriented) more and more.

SCENARIO #1: We need technologies, but not at the expense of basic education. As the technology develops, we can take advantage of growing sophistication and invest at the best time. Let's keep our current implementation level, work on developing curricula, stall schools in their attempts to acquire equipment and software until we're more confident about where everything is going. We know that test scores are continually falling in this country related to achievement and academic performance. We can also benefit from watching the approaches used by other states.

SCENARIO #2: We need educational technologies in schools and teacher training institutions primarily. There's questionable sense in developing any plan that is doomed to fail if teachers are not prepared to meet the challenges imposed upon them through the integration of educational technologies into the classroom. Both teachers and students are having trouble finding applications to the current generations of educational technology. Just because someone receives exposure to a computer doesn't guarantee that they are either sufficiently expert at using such technology in the classroom, or capable of integrating it into existing curriculum objectives. The impact of technology versus other educational measures on children is something with which we should not gamble.

SCENARIO #3: The state should acquire another 18,000 computers. This will cost the tax payer

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$36 million and will provide one computer for every classroom in the state. At this level, children will have exposure of 30 minutes per week to a computer at school on average. We're looking at a decreasing teacher pool in this state with increasing student enrollments. As the trend in both of these areas continues, we'll be relying upon technology to fill more and more of the gap. If we don't begin now, we're not going to have enough computers to adequately inservice our currently practicing teachers. Let's set curriculum guidelines, declare teacher certifications and/or competency-based standards and fully develop scope-and-sequence materials for computer-based education in our state.

THE ACCOUNTING DILEMMA

ACCOUNTING

No matter which scenario we use, it appears that technology is not being defined as a research and development cost among schools even though that may

be, in fact, what schools are doing. Pogrow states that at least ten states are now spending over $1 million in state funds to support projects in educational computing.

Both formal and informal research and development is taking place that is rarely stipulated by contract in many school systems. While one of the scenarios described above asked whether or not we should "gamble" with our childrens' futures through experimentation with educational technologies, it may well be the case that schools as a whole are going to have to literally "experiment" in order to find the right blend of human, traditional and technological components for their specific educational environment and milieu that will "work."

Research and development costs can be handled several ways. From the standpoint of the taxpayer, who may wish to see such costs as write-off expenses

in schools acquiring technology, this is an important operational decision that commits an institution to a direction. This is a more conservative stance that tends to promote more steady payments that will be reflected in school operating statements, rather than in the fluctuation of successes and failures. Current school practice on the whole is guessed to reflect an attitude that, from an accounting perspective, becomes translated as deferred charges. Schools may be carrying on technology acquisition and then declaring those expenses as fixed assets -- even though the ultimate worth of technology in schools has not been clearly established. We suspect that teacher research into educational computing, apart from school-sanctioned activities, frequently involves programming, intensive self-initiated study, program development time, acquisition and utilization of traditional classroom

materials for non-curricula oriented activities, and frequent use of ancillary personnel who become part of a largely unspecified, unsupervised and unevaluated system of projects. While there may be some justification for the encouragement of independent study and initiative in other, less volatile areas (even if they involve school materials which must be accounted for), we believe there is not enough recognition that what we are witnessing may be widespread and therefore worthy of greater scrutiny.

MARKET VARIABLES

PRICE ATTRITION

The product price attrition which has so characterized educational technology certainly impacts school accounting practices. Overall material investment in schools has been on a steady decline through the years, and the contribution of educational technologies to the overvaluing of current assets available to schools may become an important

factor in future viability of schools to deliver services.

Additionally, the price attrition of educational technology products could have a retarding effect on the implementation and integration of necessary technologies into the classroom. The general public has often reacted to the continually shifting price structure of educational technology products by frequently adopting a "wait-and-see" posture.

STANDARDS

Those technologies which are most powerful, flexible and easily appropriated will be adopted by educators. One suspects that teacher response to technology is not always considered enough in the development of educational technologies. There is still the tendency for technology products to require the adaptation of the user to the system instead of the other way around. The causes for this situation partially involve the positive

environment in which most technology developers now find themselves: few standards permits the greatest innovation and flexibility in initial development. On the other hand, the most powerful technological tools that do not make things easier for the teacher will remain relatively unused. All computer languages currently in use in education suffer from this deficiency. From our analysis, this state of affairs also operates as an advantage system since, even when countries such as Japan have adopted microcomputer operating system standards such as MSX, software developers (particularly Americans) have not flocked to produce and/or translate their products to the standard.

THE TEACHER VARIABLE

TEACHER TRAINING

From 1982 to 1983, one survey shows Arizona's growth in "computing teachers" as being 1300 to 2581. 59% of these computing teachers are at the elementary

school level. If we use 25,000 certified and actively employed teachers as the potential teacher training pool, two different opinion emerge: 1) we already have an adequate base of computing teachers; 2) we have just barely scratched the surface of preparing teachers for educational technologies. In terms of finance decision-making, it appears that the private sector in Arizona is sufficiently active to provide most teachers with an opportunity to gain exposure to some form of training without much difficulty. The appearance of a mass educational technology training facility, such as the Computer Showcase in the Phoenix area is an innovative, bold and unique venture. While there are definite issues concerning availability of such instruction for teachers in more remote areas of the state, the real issue inherent in this area concerns the

specific content, model and processes we wish to impart to teachers about educational technology.

Let us not forget, however, that the area of teacher training is likely to respond to the convergence of technologies. We hypothesize that much instruction that we are forced to provide our teachers on hardware and software operation will not be as time consuming and/or complex as it is now. Much technology related anxiety that many teachers feel does not, in fact, involve educational issues. Teachers feel anxious about the operation of the machines. Time spent on providing services to reduce machine anxiety is not necessarily promotive of higher quality education. We speculate that the appearance of facilities such as the Computer Showcase indicates an emergent trend that demonstrates teacher learning related to technology may be better handled completely outside of the school

environment.

Our teachers in this state represent one of it's most highly educated groups. With the continued proliferation of technology, and as private-sector high technologies continue to expand in Arizona, we speculate that teachers will increasingly move between school and private-sector occupations--particularly where they relate to the development of educational technologies. This mobility should be encouraged and actually represents another major long-term resource to the state if cultivated correctly. In terms of developing products grounded in experience, incorporating sound elements of pedagogy and the like, teachers as developers of educational technology may provide the new generations of sufficiently standardized products that prove truly useful to educational communities.

RECOMMENDATIONS

Using figures supplied by the Arizona Center for Vocational Education, it appears that the two largest counties in the state have approximately 61-64% of the microcomputers in business departments or immediately accessible to business department users in junior and senior high schools. Since these population areas would normally account for something on the order of 73-75% of the population in the state, it would appear that saturation has not taken place.

The 18,000 computer units projection has been arrived at through two different means: 1) projection based upon the 1:30 computer:student ratio called for by the NEA; and, 2) an estimate based upon the average number of classrooms per school in Arizona, as opposed to the number of already available computers in schools. Being as direct as possible, it is my recommendation that the necessary units be acquired as soon as possible via the mechanisms proposed herein and, by normal school acquisition channels. The recommendations are based upon giving teachers top priority in the process.

Financing either the teacher-level or the student-level of

computer usage in the schools is not strictly in-and-of-itself an answer. Nevertheless, financing is so critical an issue that to underfinance educational technology in our schools at this point may represent the surest path to mediocrity. It must be understood that future investments in our educational systems will probably involve less brick and mortar and more technology. This transition in function is based upon population demographics. To invest heavily in outmoded forms of "basic" education whose population constitutes a smaller and smaller proportion of our overall population does not make sense. We will be examining methods of "transferring technology" from different sectors of our economy to another. This idea may also serve us well in the future when, for the sake of changes in education brought about by shifting population demographics, we may want more technology at the post-high school level.

It is in the nature of the issue of financing educational technologies to ask about the return on investment (ROI). It is even more apparent to some that ROI questions will not be answered by specifying curricula, drafting legislation and/or developing additional layers of bureaucratic structure. Why? It is the shifting nature of educational technology themselves. Our focus is generally incorrect when we become so enchanted by technology that we no longer ask the best questions.

Test scores on achievement tests have been produced by

generations of test takers for quite some time now. If we examine this behavior, we could notice that at least paper-and-pencil technologies have been a rather consistent feature of educational technologies throughout this period of examination. If we were to attribute variation of test performance on the use of paper-and-pencil technology, we would probably be making a gross error in judgement. To ask whether or not the use of educational computing technology would give us the best ROI during this same period suffers from the same error in attribution.

If we were to have attacked paper-and-pencil technology and people were not to have acquired this technology for themselves, severe hardships would have been realized by those who were so deprived. The same will take place for those in our society without access to technology. Because from these new technologies are emerging the new environments in which the real processes that should be examined for ROI should be analyzed.

In a world where there is too much information, where technology must be used to assist us in determining what is real, useful and appropriate, the real measure of quality control is not the technology itself, but the performance of individuals using that technology. We have argued elsewhere that the appropriate model for schools in the future should be "performance-based measures," that include demonstrations of

competency at utilization of the technology for cognitive, social, physical and emotional purposes.

Where education could once afford the luxury of "lecturing," leaving it to the student to demonstrate proficiency of learning via infrequent testing, I would suggest to you that our present day "quality control" requirements demand something more on the level of performance demonstration (similar to musical performances). Why not just provide financing and forget the "performance" requirement? Those states which most adequately determine "applications" for educational technology both now, and in the future, will become the channels whereby the benefits of technology will flow.

It has become an inside joke among educational technology users that computers are an "answer in search of a question." And that is very true. The "questions" are the areas of application that educational technology can be most fruitfully applied. Positioned as we are around California and nearby Texas, both giants in innovation, Arizona should adopt a posture as the "APPLICATIONS STATE," where technology becomes useful. Let us not just "finance" technology, but let us examine some of the most important issues surrounding its use as finance issues. I have argued elsewhere that educational systems as a whole should adopt the 14-points advocated by W.E. Deming for quality control in education. These should become the guidelines that permit an adequate analysis of ROI. These are statistical measures. Anything else would be a waste of time.

The following represent my recommendations on financing:

DONATIONS:

Producer:

Educational technology capital equipment producers should be given incentives to donate equipment to schools. Included in this working paper is a copy of California legislation which has resulted in substantial gifts of technology to schools. Since this is a matter of political influence, we recommend utilizing consortia for this purpose -- since there are many states with similar needs and interests such as Arizona.

NACCIS has undertaken a leadership position in this regard and has contacted several groups to test interest in developing this aspect of a consortia relationship. Other state support and private-sector support are both potential categories of participants. One group, California's National Commission for Industrial Innovation--Computer in Schools Project,

DONATIONS:

Technology

Transfer -

was responsible for obtaining $27 million in donated equipment. They have contracted with Peat, Martwick and Mitchell to perform an analysis of the cost of capital related to technology in this country versus foreign competition.

In order for such incentives to be realistically applied to Arizona, mechanisms for providing them to external technology producers is the key issue. Most of the major educational technology producers are currently outside of Arizona, but it is within the realm of feasibility that plans could develop which both provide for short-term incentives to producers to donate, but also incorporates elements of incentives to attract these same producers to have production facilities within the state. As robotics and other forms of process control penetrate traditional manufacturing areas, it is highly likely that manufacturing

facilities will continue their pattern of decentralized production. We view the development of enabling legislation to provide these incentives as a priority issue. The legislation should be nonpartisan. We have discussed the possibility with various legislative personnel and found no objection to initiating work on such a program.

DONATIONS:

Citizen: Develop a tax credit plan to permit needed computer hardware and software to be donated from individuals to schools with the following phased priorities:

a. Teachers

b. Schools and Libraries

c. Non-profit educational groups

The program would involve donations of equipment and software to NACCIS, which would simply administrate the distribution of the technology within the geographic region of the donation. The tax credit would permit amelioration

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of some of the price attrition experienced by consumers of hardware and software that has occurred in the past -- and would encourage the public's participation in the promotion of quality educational technology implementation programs without direct reliance on tax dollars. Critics of such a program will probably be fearful of decreased state revenues, but the overall long-term impact of unused equipment in the hands of the consumer is probably more detrimental to state economies than donated equipment which is going to be actively used. Purchase of disk supplies, acquisition of peripheral devices such as printers, paper and the like by teachers learning to use systems is going to offset the reduction of state revenues in the short-term (the tax credit is suggested as a percentage of the original market value of the equipment). Over the long-term, the greater willingness of

DONATIONS:

. Impact on State

Tax Revenues:

the public to acquire equipment it knows it can transfer from one sector of the economy to the other may be a siginificantly profitable move. More study on this particular aspect of the proposal is, of course, needed.

It is estimated that Arizona's 3 million plus residents may harbor as many as 300,000 computer systems of various sorts under personal ownership. The teacher population is, as we have stated previously, approximately 25,000. While the formal structure of such a proposed program needs to be flushed out, the numbers indicate that the idea is within the realm of feasibility.

Additionally, given the estimate of 18,000 systems to provide one computer per classroom, we are looking at the potential for saturation of schools at this level if we so desire. The tax savings to schools would amount to $36

DONATIONS:

Transfer of

Technology Vs. Fire-Sale:

million.

Teacher Priority:

Top priority is given to teachers in this program suggestions because issues surrounding inservice education are meaningless without the capability of transfer to actual experience with the technology. Inservicing programs that seek to provide teachers with classroom lectures and minimal hands-on experience with computers are similar to thinking that you can teach people "music" through music thecry without an actual performance of some sort. Any financing scheme which ignores the necessity for well-educated teachers as a prerequisite to curriculum development is doomed to failure.

Existing inservice programs ignore the fact that computer competency is not an easily obtained skill. Intensive workshops often treat computer competency as if it were an equivalent teaching method, when it is in many cases more time consuming and more difficult than other methods that do not involve technology.

DONATIONS:

Federal Surplus: Seek priority donations and first-call on technology being discarded or sold as surplus by the military and other government agencies.

Public Resources: See Video Monitor, 2 (3), May/June 1984. Many computer clubs and community groups make extensive use of computers in their environments. They are potential resources if we care to mobilize them. From the standpoint of access to information on hardware and software, support for the neophyte learner and trouble-shooting, these groups are not

adequately incorporated in many an analysis of available resources. Many libraries now have computers which could be made available for training purposes with coordination.

2. FINANCING PROTOCOLS:

1) Pursue the donation programs outlined above as the first priority. Direct financing is less adequate choice for short-term acquisitions at this point (computers) and should be planned for the more convergent forms of technology which will be prominent 5-10 years from now, and even more prevalent 15-20 years from now.

2) Direct purchase technology items that enhance primary use items such as computers primarily for administrative and management tasks in greater proportion than expenditures for instructional use. As the instructional media improves, shift buying to that end

of the scale as the tax demographics indicate a readiness for this.

3) Avoid single use items for acquisition, such as a program that does one thing and one thing only. Superior programs frequently have multiple capabilities and extended applications. The best technology appears to be formed around powerful "shells" (such as spreadsheets) that permit users to adapt them to their particular situation.

4) The most technology oriented firms within our own geographic region should be immediately pressed into service to assist in the development of long-term research oriented efforts that will improve educational technology applications in our area. Avoid reinventing the wheel and follow examples of excellent research conducted elsewhere and synthesize into our programs. This requires the

establishment of a body in Arizona which will coordinate the oversight of educational technology implementation. Positioned as we are around technology intensive states such as California and Texas, and in close proximity to an international border area, the establishment of an Arizona MITI is not a minor issue. Japan's successes in world markets have less to do with "miracles" and more with sound economic, industrial, market and social intelligence. The absence of a JETRO office in this state is a distinct comment.

5) Schools should provide evidence of working with their local PTA-PTO's in achieving their particular level of technology acquisition. The state educational technology group could also coordinate buying with the state level PTA-PTO's to maximize efficiency.

Every School - A Computer and A Modem:

6) Finance of technology in schools should emphasize convergence of technologies. Recommendations of acquisition of telecommunications software and hardware will permit the state to more adequately assess the progress of implementation through networks to be developed in the future. Additionally, these networks will be multipurpose technologies. Teacher training, data collection, communications, provision of services to specific underserved areas, and other possibilities are easily within reach if the protocol is adopted.

7) Encouragement of teacher credit unions, banks and other financial institutions serving teachers to provide low interest-rate loans for the acquisition of technology, software, training, and/or short-term development.

DATA ENTRY

STANDARDIZATION: One of the great areas of waste that is currently unchecked in many areas involves costs associated with data entry. Due to the unwillingness and inability of many agencies to eliminate keyboard data entry through adoption of a standard that would permit greater use of scanning devices in as many areas as possible, the potential exists for the state to exert leadership and effect savings which could then be passed on to educational technology objectives.

1) Use library system book cards that utilize optical scanning as the basis for a statewide system of data entry based on both character and bar code input. Standardize around requirements for the type of data that will be required and the format used, where such adoption of optical character or bar coded input will provide maximal benefit with the least disruption of existing

services and/or operation. Teachers should develop their tests and in-school evaluations around materials which can be easily machine-read. School registrations, motor vehicle forms, surveys, research instruments and the like in all Arizona agencies should be converted if there is enough evidence of potential gain to justify the transition.

Capital Accumulation and Equalization:

Pogrow has suggested that there needs to be a lessening of the restrictions on the accumulation of surpluses and charging of depreciation costs. He has suggested that the state assist in the equalization process. These measures along with the previously discussed need to more accurately account for technology expenditures as a research and development cost would provide the state with the most accurate picture of

school needs for technology.

NACCIS WORKING PAPERS
84.07.08 - Steve
FINANCING TECHNOLOGIES - ARIZONA

READINGS

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READINGS

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APPENDICES

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ARIZONA SCHOOLS COMPUTER SURVEY SORT BY COUNTY

COUNTY	SCHOOL NAME
APAC	CHINLE HIGH
APAC	VALLEY HIGH
APAC	WINDOW ROCK
APAC	ROUND VALLEY H.S.
APAC	ROUGH ROCK HIGH
COCH	BUENA HIGH
COCH	DOUGLAS HIGH
COCH	ST. DAVID HIGH
COCH	SAN SIMON HIGH
COCH	TOMBSTONE HIGH
COCH	VALLEY UNION
COCH	WILCOX HIGH
COCH	BISBEE HIGH
COCO	COCONINO HIGH
COCO	FLAGSTAFF
COCO	GRAND CANYON
COCO	WILLIAM HIGH
GILA	CENTRAL HIGH
GILA	GLOBE HIGH
GILA	HAYDEN HIGH
GILA	MIAMI HIGH
GILA	PAYSON HIGH
GRHM	THATCHER HIGH
GRHM	PIMA HIGH SCHOOL
GRHM	FT. THOMAS HIGH
GRLEE	CLIFTON HIGH
GRLEE	DUNCAN HIGH
GRLEE	MORENCI HIGH
LA PAZ	SALOME HIGH
LA PAZ	PARKER HIGH
MAR	AGUA FRIA
MAR	ALHAMBRA
MAR	ARCADIA HIGH
MAR	AREA VOCATIONAL CENTER
MAR	BUCKEYE UNION HS
MAR	CACTUS HS
MAR	CAMELBACK HS
MAR	CARL HAYDEN HIGH
MAR	CHAPARRAL HIGH
MAR	CORONADO HIGH
MAR	DEER VALLY HIGH
MAR	DOBSON HIGH
MAR	GANADO HIGH
MAR	GLENDALE HIGH
MAR	GREENWAY HIGH
MAR	HORIZON
MAR	INDEPENDENCE HIGH
MAR	MARCOS DE NIZA
MAR	MARYVALE HIGH
MAR	MCCLINTOCK HIGH

ARIZONA SCHOOLS COMPUTER SURVEY SORT BY COUNTY

COUNTY	SCHOOL NAME
MAR	MESA CENTRAL VOC-TECH
MAR	MESA HIGH SCHOOL
MAR	MOON VALLEY HIGH
MAR	MOUNTAIN VIEW
MAR	NORTH HIGH
MAR	PARADISE VALLEY
MAR	SCOTTSDALE ALTER.HIGH
MAR	SHADOW MOUNTAIN
MAR	SOUTH MOUNTAIN HIGH
MAR	SUNNYSLOPE HIGH
MAR	TEMPE HIGH
MAR	THUNDERBIRD
MAR	TOLLEMSON HIGH
MAR	TREVOR BROWNE
MAR	WASHINGTON
MAR	WESTWOOD HIGH
MAR	GILBERT HIGH
MAR	PEORIA HIGH
MAR	POLARIS HIGH
MAR	WICKENBURG
MAR	FREMONT JHS
MAR	GREENWAY JHS
MAR	PVAC/AVC
MAR	POWELL JR. HIGH
MOH	KINGMAN HIGH
MOH	MOHAVE HIGH
NAV	ALCHESAY HIGH
NAV	BLUE RIDGE HIGH
NAV	HOLBROOK HIGH
NAV	MONUMENT HIGH
NAV	SHOW LOW HIGH
NAV	SNOWFLAKE HIGH
PIMA	AJO HIGH
PIMA	AMPHITHEATER HIGH
PIMA	CANYON DEL ORO
PIMA	FLOWING WELLS
PIMA	MARANA HIGH
PIMA	PALO VERDE HIGH
PIMA	PUEBLO HIGH
PIMA	RINCON HIGH
PIMA	SABRINO HIGH
PIMA	SAHUARO HIGH
PIMA	SANTA RITA
PIMA	TOWNSEND JR. HIGH
PIMA	CATALINA HIGH
PIMA	SUNNYSIDE
PIMA	EMILY GRAY JHS
PIMA	SAHUARITA HIGH
PINAL	CASA GRANDE HIGH
PINAL	COOLIDGE PINAL

ARIZONA SCHOOLS COMPUTER SURVEY SORT BY COUNTY

COUNTY	SCHOOL NAME
PINAL	SAN MANUEL HIGH
PINAL	MARICOPA HIGH
PINAL	RAY HIGH
PINAL	SUPERIOR HIGH
S.CRUZ	SANTA CRUZ
YAV	ASH FORK HIGH
YAV	CAMP VERDA HIGH
YAV	PRESCOTT HIGH SCHOOL
YAV	SELIGMAN HIGH
YAV	MINGUS HIGH
YUMA	KOFA HIGH
YUMA	MAYER HIGH
YUMA	YUMA HIGH

ARIZONA COMPUTER DISTRIBUTION BY COUNTY

COUNTY	RS1	RS2	RS3	RS4	DWP	PET	SPT	CBM	803	C64	DM	IBM	SY6	DCM	DC2	DC1	FRN	AP1	AP2	AP+	IIE	AP3	OTH
* TOTAL BY COUNTY APAC																							
** SUBTOTAL **	0	0	2	0	0	3	0	1	1	0	0	0	0	0	0	0	0	0	16	0	23	0	0
* TOTAL BY COUNTY COCH																							
** SUBTOTAL **	2	3	35	11	0	7	5	0	0	0	0	0	0	0	0	0	3	0	13	0	23	1	0
* TOTAL BY COUNTY COCO																							
** SUBTOTAL **	12	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	10	0	12
* TOTAL BY COUNTY GILA																							
** SUBTOTAL **	6	4	9	1	0	7	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0
* TOTAL BY COUNTY GRHM																							
** SUBTOTAL **	0	0	0	0	0	40	3	0	3	1	0	0	0	0	0	0	0	0	0	0	2	0	4
* TOTAL BY COUNTY GRLEE																							
** SUBTOTAL **	1	3	0	0	0	5	0	15	0	0	0	0	0	0	0	0	7	0	2	0	8	2	1
* TOTAL BY COUNTY LA PAZ																							
** SUBTOTAL **	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	15	0	0
* TOTAL BY COUNTY MAR																							
** SUBTOTAL **	24	4	254	32	3	65	99	32	39	0	0	4	0	0	0	0	10	0	79	0	227	0	0
* TOTAL BY COUNTY MOH																							
** SUBTOTAL **	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	14	0	0
* TOTAL BY COUNTY NAV																							
** SUBTOTAL **	0	1	31	0	2	0	0	4	0	0	0	0	1	2	0	0	0	0	12	0	4	0	44

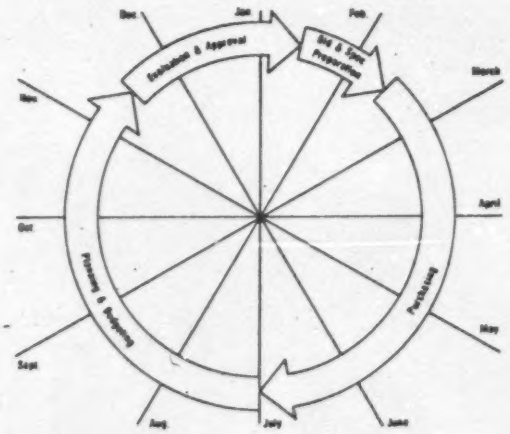
ARIZONA COMPUTER DISTRIBUTION BY COUNTY

COUNTY	RS1	RS2	RS3	RS4	DWP	PET	SPT	CBM	803	C64	DM	IBM	SY6	DCM	DC2	DC1	FRN	AP1	AP2	AP+	IIE	AP3	OTH
* TOTAL BY COUNTY PIMA																							
** SUBTOTAL **	4	2	119	29	0	0	0	0	0	0	1	81	16	0	0	0	0	0	14	2	24	0	2
* TOTAL BY COUNTY PINAL																							
** SUBTOTAL **	3	0	19	8	0	24	0	0	0	0	0	1	0	0	0	0	0	0	2	0	15	0	16
* TOTAL BY COUNTY S.CRUZ																							
** SUBTOTAL **	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	9	0	0
* TOTAL BY COUNTY YAV																							
** SUBTOTAL **	0	0	18	0	0	27	0	1	1	0	0	0	0	0	0	0	0	0	7	0	4	0	0
* TOTAL BY COUNTY YUMA																							
** SUBTOTAL **	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	16	0	5
** TOTAL **	52	19	496	81	5	178	107	53	44	1	1	86	17	3	0	0	20	0	186	2	394	3	84

14

Computer+Software News, July 2, 1984

Purchasing cycle in schools and colleges



Source: T. H. E. Journal. The Education Marketplace for Microcomputer

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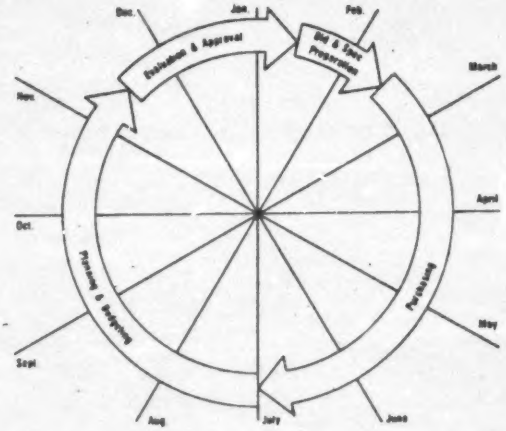
Computer+Software News, July 2, 1984

Purchasing cycle in schools and colleges



Source: T. H. E. Journal, The Education Marketplace for Microcomputer

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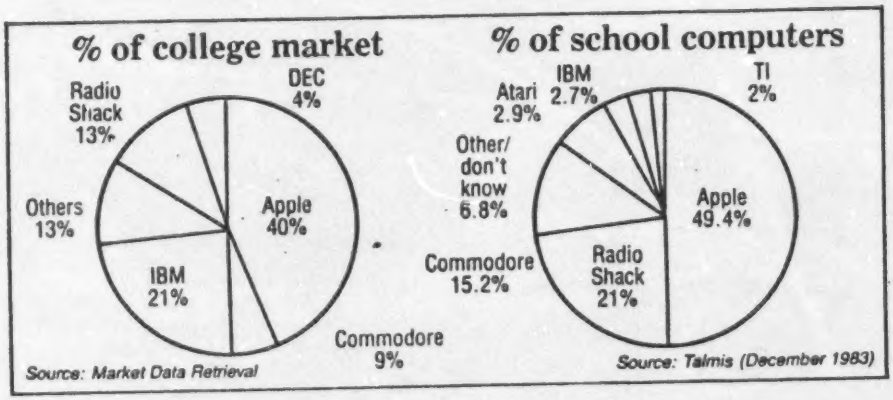

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Key buyers in public school districts

Job title	Administrators Superintendent Asst. superintendent/ Asst. superintendent/ administr.	Directors Instructional systems Instuctional materials Learning resources Computer center Outside consultants	Department Chairmen Math Science Vocational education Business, etc.
Role on committee	Approval	Technical consultants	User/managers
Representation on committee	20%	60%	20%
Job title	Executives and Administrators President, provost, chancellor vp of fiscal affairs vp of academic affairs	Directors Instructional systems Instructional materials Instructional technology Learning resources Computer center Outside Consultants	Department Chairmen and Professors Engineering Computer sciences Physics Economics, statistics Math Business Languages, etc.
Role on committee	Approval	Technical consultants	User/managers
Representation on committee	15% (or veto)	20%	30%

Source: T.H.E. Journal. The Education Marketplace for Microcomputers, October 1983.

Of the approximately 17,000 public school districts, 80% of dollar volume purchases are made by about 30% of the districts. Decisions are typically generated from a committee. Key committee decision makers are most often directors of some branch of school services. Decentralized buying occurs at some 3,200 colleges and universities, where department chairmen wield the greatest authority. Budgeting and approval, however, are still required from university executives.

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Fall 1983: Micros by brand in public schools

Brand	Units	% of total	Rank	% of schools
Apple	153,719	51.3	1	54.1
Radio Shack	70,093	23.4	2	20.8
Commodore	47,888	15.9	3	13.5
Atari	9,780	3.3	4	3.3
IBM	6,008	2.0	5	1.8
TI	5,747	1.9	6	2.6
Franklin	4,337	2.5	7	1.4
Other	1,808	0.6	8	2.7
Total	**299,380**			

Source: Quality Education Data (QED), Denver, Colo. 1983-84 Microcomputer Usage in Schools.

The current number of micros in public schools actually runs between 300,000 and 325,000, representing a penetration of about 68% of all public schools. Apple has been the clear leader since 1981, when QED first surveyed districts. QED recently reported that 9,068 of the 9,272 districts with more than 600 students, are using at least one micro for classroom instruction. By comparison, in the fall 1981 survey, less than half of these districts had any micros.

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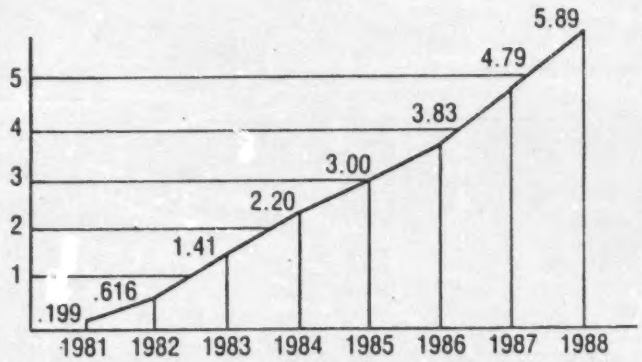
Micro unit shipments to U.S. schools/colleges, 1981-88

(in millions)



Source: Creative Strategies International, San Jose, Calif. Reprinted from The Educational Marketplace for Microcomputers, *published by* T.H.E. Journal, *October 1983.*

The present installed base of 1.4 million units will more than quadruple by 1988, representing a compound annual growth rate of about 40%. The great potential for multi-unit purchases, and consequent lower sales cost per unit, ranks the educational market alongside Fortune 1,000 corporations for large-quantity shipments.

1983 MICROCOMPUTER USAGES IN ARIZONA PUBLIC SCHOOL CLASSROOMS

Subjects	Usage				Drill/Practice				Simulations				Tutorials			
	K-3	4-6	7-8	9-12	K-3	4-6	7-8	9-12	K-3	4-6	7-8	9-12	K-3	4-6	7-8	9-12
BASIC SKILLS:																
Math	186	246	122	87	179	228	108	71	23	42	23	20	81	108	69	42
Spelling	109	143	40	30	100	126	34	26	4	3	2	3	36	44	16	14
Reading	139	160	61	31	118	132	50	24	16	24	14	7	69	79	30	19
Grammar	94	133	39	23	76	107	31	19	9	8	1		47	61	17	13
Writing	32	42	15	18	16	22	8	7	13	14	7	9	8	10	2	3
ART	12	9	2	2	3	3			1	1	1		1	1		1
BUSINESS EDUCATION	9	12	17	196	2	2	7	69	2	3	7	61	3	4	6	38
COMPUTER LITERACY	0	168	138	139	36	67	51	55	14	33	27	46	24	43	46	42
COMPUTER SCIENCE	49	91	86	138	23	36	34	60	8	14	20	52	13	25	26	38
ENGLISH	17	43	23	22	15	29	19	16	2	3	1	3	8	26	11	11
FOREIGN LANGUAGE	5	4	2	5	3	3	1	4	1			1	2	1		2
HEALTH	2	8	1			3	1		1	3			1	2		
HOME ECONOMICS				4				1				3				
INDUSTRIAL ARTS	1	2	2	5	1	1	1	4	1	1	1	4	1	1	1	3
MARKETING	3	6	1	2	1	2		1	2	5	1	2	1	2		1
MATH (algebra, geometry, etc.)	14	27	39	55	11	20	28	38	2	3	3	12	9	12	19	26
MUSIC	2	3	3	5	2	3	2	2	1		2	3	1	1	2	3
SCIENCE	17	30	22	45	8	13	10	33	6	12	7	27	7	13	13	31
SOCIAL STUDIES	27	60	22	14	14	38	10	6	15	28	10	8	8	18	5	4
TOTAL	808	1187	635	731	608	835	395	436	121	197	127	261	320	445	263	291

More ways teachers are using computers:	1983	1982
Classroom attendance	5%	2.9%
Grades	27%	5.8%
Test Scoring/Processing	13%	0
Worksheet/Quiz Generation	16%	.3%
Diagnostic/Prescriptive Evaluation	10%	0
Motivation/Reward	40%	0
Word Processing	24%	0
Skill Monitoring	13%	0
Games	not included	0

1983 ARIZONA SCHOOL SURVEY OF COMPUTERS IN INSTRUCTIONAL USE

Arizona Department of Education
Carolyn Warner, Superintendent
Dr. Jim Hartgraves, Deputy Superintendent
June 1983

1983 ARIZONA COMPUTER SURVEY OF MICROCOMPUTERS BEING USED FOR INSTRUCTION

PRINCIPALS' SURVEY

	1983	1982
Number of respondents	623 (69%)	465 (52%)
Number of schools using computers for instruction	476 (76%)	314 (67%)
Number of microcomputers	4054	1515
Top microcomputer brands:		
Commodore	1890 (47%)	568 (38%)
TRS-80	1258 (31%)	653 (43%)
Apple	625 (15%)	246 (16%)
Atari	131	0
Texas Instruments	61	34
Franklin	20	0
IBM Personal	43	0
Others	26	14
Memory size:		
256		1
128	21	
96	2	26
64	410	144
48	736	252
32	1497	179
28		1
16	1222	574
8	66	44
4	153	28
Peripherals:		
Disk drives	1795	597
Cassettes	1707	631
Printers	823	357

	1983	1982
Plans for expansion:		
Within six months	261 (46%)	144 (31%)
Six months to three years	309 (50%)	169 (36%)
Add more hardware	402	95
Expand memory	103	
Add peripherals	176	
Expand to more grade levels	239	
Expand to more subjects	287	104
Other (most were increasing software or setting up labs)		
Number of schools planning to purchase for the first time	129 (20%)	
Number of computer-using teachers identified by principals:	2581	1300
Elementary	1545	691
Junior High	581	264
High School	311	345
Range in the number of computer-using teachers in the schools	1:40	1:40
Average number of computer-using teachers in the schools	5	5

TEACHERS' SURVEY

	1983	1982
Number who responded	917 (36%)	312 (24%)
Usable instruments	817*	
Grade levels taught:		
Elementary, K-6	46%	42%
Junior High, 7-8	16%	22%
High School, 9-12	38%	36%
Most frequent number of students per teacher	25	30
Student users:		
Regular	78%	60.6%
Gifted	39%	43.9%
Remedial	36%	32.1%
Special Education	24%	25.0%
Disadvantaged	10%	9.0%
Bilingual	14%	10.6%

*Fifty were too late to be included in Computer run.

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TECHNOLOGIES IN EDUCATION
(TIE) CONFERENCE
V.I.P. SESSIONS

The Climate Favors Educational Technologies in Arizona

The growth record of Arizona is well established. During the decade of the 19'0's, Arizona was the second most rapidly growing state in the nation with population up more than 53%. Population growth was matched by employment growth, which increased more than 83%. Personal income expanded more than 264% during the 1970's.

Arizona also outperformed the U.S. economy during the 1980-1982 economic malaise. Arizona tends to growth much more rapidly than the U.S. as a whole during periods of expansion but only slightly more rapidly than the nation during periods of recession.

In terms of people, we are talking about the general liveability of an area, including lifestyle, recreation, density, climate, educational and cultural facilties, and so on. The factors are subjective, but interviews with executives and individuals who have relocated or started companies in Arizona suggest that a combination of climate and lifestyle makes Arizona an attractive place to work, and raise a family.

Elliott D. Pollack, Vice President
Valley National Bank

The TIE Conference is drawing together the most significant sectors of our economy as it relates to educational technologies: financiers, investment houses, v nture capital groups, banks, technology researchers, technology producers and educational technology users. Additionally, if you are an educational technology producer looking for a strategic plant location with an attractive social and economic climate, the NACCIS TIE Conference is holding a special V.I.P. Session on March 18th and 19th, 1985 just for you.

As a V.I.P. Session participant, you'll be able to informally meet with key state, municipal, educational, venture capital and patent house representatives. Interpretors are available with advance notice. Please take advantage of this unique opportunity and R.S.V.P.

Teacher Shortage Growing

Teachers in a number of fields are in short supply, pointing to a crisis of growing proportions, according to a report just issued by the ASU Office of Career Services.

Titled "Teacher Supply and Demand in Arizona--Fall 1984," the report ticks off these eye-openers:

1--A 25 percent increase in elementary student enrollment between now and the end of the decade (a jump from about 440,000 to about 540,000).

2--An increase of about 15,000 secondary students in the same period.

3--Right now there are only 47 students preparing to be English teachers in all of Arizona's universities; yet the projected need for this Fall is 165.

4--Only 31 are preparing to be Math teachers to fill an estimated 123 openings.

5--Only 63 are preparing to be social studies teachers for a projected need of 107.

6--To fill the estimated 1,136 elementary teacher vacancies this fall, only 662 students are enrolled right now.

7--In special education (handicapped) 161 students are preparing to fill a projected 269 slots this fall.

See accompaning charts from the report for other areas of shortage.

Ray Castillo, co-author of the report along with Elaine Stover, also said that the number of education bachelor degrees declined from 2,187 in 1975 to 1,156 in 1983--that is a drop of nearly half in the last eight years.

AEA President Dennis Van Roekel pointed to the statistics as "sad evidence that Arizona is failing to reward teachers enough to make the profession an attractive career choice for today's college students."

He indicated further that a major push must focus on the next legislature to remedy the situation by "taking schools as seriously as they take prisons or hospitals."

COMPARISION OF UNDERGRADUATE EDUCATION DEGREES CONFERRED IN ARIZONA IN 1974-75 and 1982-83

ACADEMIC YEAR 1982-83

Bachelor in Education Graduates from 4 year Institutions Offering Teacher Preparation in Arizona:

Arizona State University	503
University of Arizona	396
Northern Arizona University	236
Grand Canyon College	21
TOTAL	1156

ACADEMIC YEAR 1974-75

Arizona State University	1086
University of Arizona	579
Northern Arizona University	448
Grand Canyon College	74
TOTAL	2187

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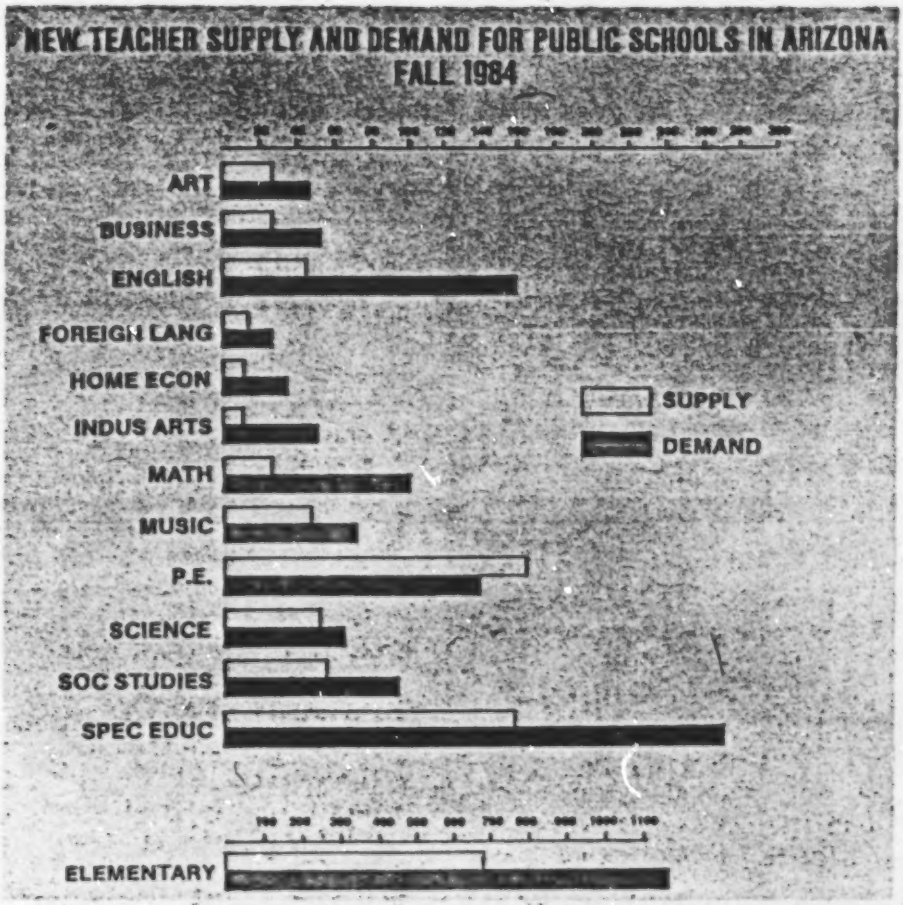

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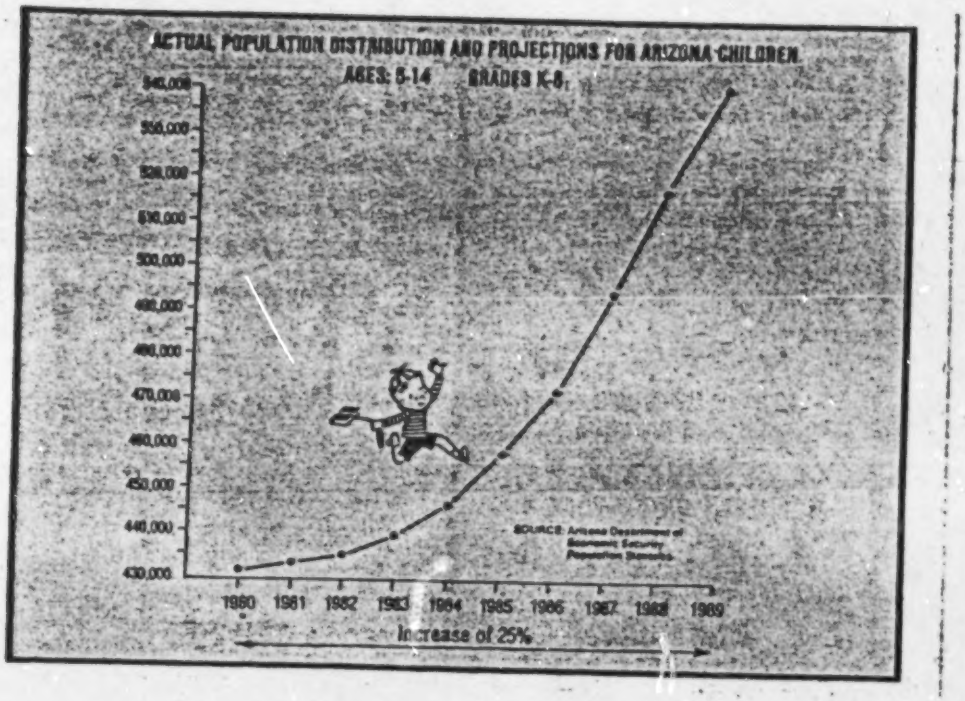

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